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Imaging

Ultrasound imaging for the rheumatologist XLV. Ultrasound of the shoulder in psoriatic arthritis

L. Riente[1], A. Delle Sedie[1], E. Filippucci[2], A. Iagnocco[3], G. Sakellariou[4], R. Talarico[1], L. Carli[1], L. Di Geso[2], F. Ceccarelli[3], S. Bombardieri[1]

[1]Rheumatology Unit, University of Pisa, Pisa, Italy; [2]Cattedra di Reumatologia, Università Politecnica delle Marche, and Ospedale A. Murri, Ancona, Italy; [3]Rheumatology Unit, Dipartimento di Medicina Interna e Specialità Mediche, Sapienza Università di Roma, Policlinico Umberto 1°, Rome, Italy; [4]Division of Rheumatology, IRCCS Policlinico San Matteo Foundation, Pavia, Italy.

Lucrezia Riente, MD
Andrea Delle Sedie, MD
Emilio Filippucci, MD
Annamaria Iagnocco, MD
Garifallia Sakellariou, MD
Rosaria Talarico, MD
Linda Carli, MD
Luca Di Geso, MD
Fulvia Ceccarellli, MD, PhD
Stefano Bombardieri, MD, Professor of Rheumatology

Please address correspondence and reprint requests to:
Dr Lucrezia Riente,
U.O. Reumatologia,
Dipartimento di Medicina Clinica e Sperimentale,
Università di Pisa,
Via Roma 67,
Pisa 56126, Italy.
E-mail: lucrezia.riente@med.unipi.it

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ABSTRACT

Objectives. *The aims of this study were to investigate the prevalence of ultrasound (US) pathologic abnormalities in the shoulders of psoriatic arthritis (PsA) patients and to compare them with the main clinical findings.*

Methods. *Ninety-seven PsA patients were enrolled in the study. The subacromial/subdeltoid bursa, the sheath of the long biceps tendon, the glenohumeral joint and the acromion-clavicular joint were examined for the presence of synovial effusions and synovial hypertrophy. Rotator cuff tendons (supraspinatus, subscapularis, infraspinatus) were imaged for tendinosis, calcifications and total or partial tears, while deltoid enthesis were evaluated for local enthesitis and the lesser and greater tuberosity of the humerus for the presence of enthesophytes.*

Results. *Tendinosis represented the most frequent abnormal finding. Supraspinatus tendinosis was detected more often than subscapularis and infraspinatus tendinosis. When considering tendon tear, supraspinatus was also the most frequently involved anatomical structure. Clinical examination frequently failed to detect abnormalities in patients in whom US examination showed pathological findings. This is particularly true for tendon involvement, i.e. effusion within the sheath of the biceps tendon was imaged in 43 shoulders but clinical assessment reported abnormalities only in 22 shoulders ($p<0.0001$).*

Conclusions. *US examination appears to be a useful and sensitive imaging technique, specifically in identifying joint and tendon involvement of the shoulder.*

Introduction

Psoriatic arthritis (PsA) is a chronic inflammatory arthropathy associated with psoriasis which can involve peripheral and axial joints. Classified as a spondyloarthropathy, it shares many clinical and radiological features with other rheumatic disorders in the spectrum of spondyloarthritis, such as ankylosing spondylitis (AS) or reactive arthritis. Enthesitis, dactylitis and arthritis with frequent involvement of sacroiliac joints and spondylitis are observed in PsA patients (1). It is known that shoulder involvement occurs in up to 50% of AS patients, but little is known on the prevalence and the outcome of shoulder joint involvement in PsA (2).

In the last decades, several radiographic imaging modalities, including magnetic resonance imaging (MRI) and ultrasonography (US), have been explored for accurate and early diagnosis of arthritis, and particularly of rheumatoid arthritis, and there is now growing interest for their use in spondyloarthritis (3-6). US is already established as an attractive imaging technique and has been successfully used in the assessment of shoulder involvement in rheumatic disorders (7). However, to the best of our knowledge, so far, very few studies have evaluated US examination of shoulder joints in PsA patients (8).

The aim of this multicentre study was to investigate the prevalence of US pathologic abnormalities in the shoulders of PsA patients and to compare them with the main clinical findings.

Patients and methods

The study included ninety-seven consecutive PsA patients (male/female ratio: 43/54; mean age 51±14 years, min: 18, max: 83) attending the out-patient and in-patient clinics of four Rheumatology Units (University of Pisa, Università Politecnica delle Marche, University of Pavia and Sapienza University of Rome, Italy), examined from

October 2012 to January 2013. The diagnosis of PsA was made according to the Classification Criteria for Psoriatic Arthritis (CASPAR) (9). The primary aim of the study was to assess the prevalence of US pathologic abnormalities in the shoulders of PsA patients and to compare them with the clinical profile. The secondary aim was to explore any potential correlations between demographic features, clinical pattern and prevalence of US pathologic abnormalities of the shoulders in the cohort examined. Therefore, data regarding sex, age, clinical features, US abnormalities, body mass index (BMI) (10) and quality of life (by means of validated questionnaires) were collected in an electronic database. Patients who received corticosteroid injections in the shoulder within the 3 months prior to the study were excluded from the evaluation. Demographic and clinical characteristics of the cohort studied are summarised in Table I.

Table I. Demographic profile.

Number of patients	97
M/F	43/54
Mean ± SD age (min-max) (years)	51±14 (18–83)
Mean ± SD disease duration (min-max) (months)	95±13 (2–576)
Disease duration (months)	Number of patients
<12	10
12–24	13
24–60	26
>60	48

Table II. Shoulder clinical evaluation (provocative tests) in PsA patients.

	Right (n=97)	Left (n=97)	Total joints (n=194)
Hawkins's test (n/%)	16/16.4	12/12.4	28/14.4
Patte's test (n/%)	8/8.2	6/6.2	14/7.2
Jobe's test (n/%)	20/20.6	15/15.4	35/18
Gerber's test (n/%)	10/10.3	8/8.2	18/9.2
Speed test (n/%)	16/16.5	14/14.4	30/15.5

Table III. US-detected features at the level of the rotator cuff tendons.

	Tendinosis			Tears*		
	Right n=97	Left n=97	Total n=194	Right n=97	Left n=97	Total n=194
Supraspinatus (n/%)	43/44	37/38	80/41	16/16	7/7	23/12
Subscapularis (n/%)	23/24	20/21	43/22	1/1	2/2	3/1.5
Infraspinatus (n/%)	16/16	13/13	29/15	0/-	0/-	0/-

*partial-thickness or complete tear.

Clinical assessment

All the patients were assessed for history of shoulder pain and underwent a complete clinical assessment of the shoulder by an expert rheumatologist for the presence/absence of pain and tenderness. The Hawkins test, Jobe test, Patte test, Gerber test and Speed test were the provocative maneuvers performed to provide a more focused evaluation for impingement syndrome, rotator cuff tendinopathies and biceps brachi pathology, respectively (11).

All the patients underwent a comprehensive rheumatologic evaluation; DAS28 was used to evaluate the disease activity. The physicians conducting the clinical and US examinations were blinded to the results of each other's findings

Ultrasonographic assessment

In each of the 4 participating units in the study, US examinations (including both grey-scale and power Doppler examinations) were carried out using a MyLab TWICE XVG machine (Esaote, Genoa, Italy) with a linear probe operating at 4-13 MHz and a Logiq 9 machine (General Electrics Medical Systems, Milwaukee, WI, USA) with a linear probe operating at 9-14 MHz by a single rheumatologist who was well experienced in musculoskeletal US. Before the start of the study, all the sonographers reached an agreement both on the scanning technique and the definition of the pathological findings to detect.

In all patients, US examination of both shoulders was performed according to the EULAR guidelines (12). The subacromial/subdeltoid bursa, the subscapular bursa, the sheath of the long biceps tendon, the axillary and posterior recesses of the gleno-humeral joint (GHJ) and the acromion-clavicular joint (ACJ) were examined for the presence of synovial effusions (SE) and synovial hypertrophy (SH). When synovial hypertrophy was detected, power Doppler examination was performed and the following settings used: PRF 500 Hz, Doppler frequency 7.1–7.5 MHz and Doppler gain to avoid random noise visualisation.

Rotator cuff tendons (supraspinatus, subscapularis, infraspinatus) were imaged for the presence of tendinosis, local calcifications and total or partial tears.

The ACJ was examined for osteophytes and erosions as well as fibrocartilage calcifications. The GHJ was also evaluated for the assessment of labrum calcifications, intra-cartilagineous crystal material (double contour sign), tophaceous deposits and erosions (with or without local PD signal).

Finally, we imaged the deltoid enthesis at the acromion attachment for local enthesitis (defined according to D'Agostino *et al.*), and lesser and greater tuberosity of the humerus for the presence of local enthesophytes (8, 13).

All abnormalities were studied according to the internationally accepted definitions and scored according to a dichotomous assessment (14, 15). In addition, calcifications were assessed

for the presence of acoustic shadowing and their maximal dimension was measured.

Statistical analysis

All results are expressed in means ± standard deviation (SD). Chi-square test, *t*-test and ANOVA were used to evaluate the differences between the subgroups. A p-value <0.05 was considered statistically significant. All calculations were made using StatView program ver. 5.0.

Results

From a clinical point of view, 54 patients showed active joint involvement (defined according to a DAS28 >2.6) at the time of US evaluation, 43% of whom with peripheral joint involvement, and 9% with axial joint involvement only; the other subjects were characterised by the concomitant presence of axial and peripheral involvement. Moreover, monolateral pain and/or tenderness elicited by physical examination was found in 21 patients, while in 20 cases shoulder pain was bilateral (Table II).

Globally, 194 shoulder joints of 97 patients were studied. Using US, abnormalities of the rotator cuff tendons were frequently observed; in particular, tendinosis represented the most frequent abnormal finding (Table III). Supraspinatus tendinosis was detected more often than subscapularis and infraspinatus tendinosis: in 80/194 (41%), 43/194 (22%) and 29/194 (14.9%) shoulders, respectively. Moreover, calcifications within supraspinatus tendon were visualised more commonly with respect to subscapularis and infraspinatus tendons: in 35/194 (18%), 9/194 (4.6%) and 4/194 (2%) shoulders, respectively. The dimensions of the rotator cuff tendon calcifications were between 0.4–6.1 mm, with acoustic shadowing present in 18 (9%) out of 194 shoulders. Bilateral tendinosis of the supraspinatus was imaged in 13 patients, of both supraspinatus and subscapularis in 7 patients and of the three main components of rotator cuff, supraspinatus, subscapularis and infraspinatus in 9 patients. When considering tendon tear, the supraspinatus was also the most frequently involved anatomical structure (Fig. 1). In fact, partial-thickness or complete tear of the supraspinatus and subscapularis were visualised in 23/194 (11.8%) and 3/194 (1.5%) joints, respectively, while no infraspinatus tendon tear was observed. Bilateral supraspinatus tear was detected in 4 patients.

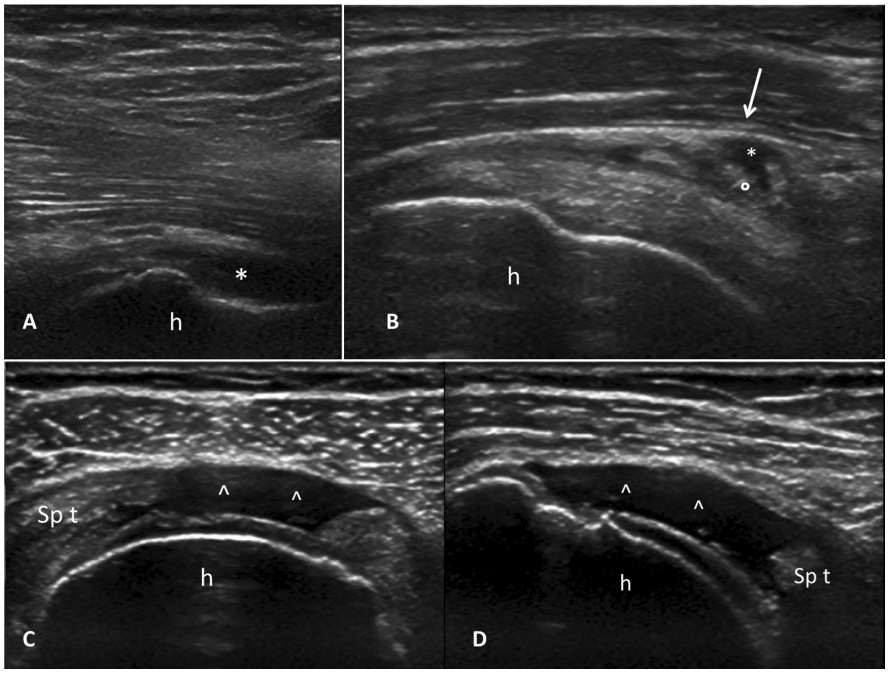

Fig. 1. A. Axillary recess of the gleno-humeral joint with evidence of joint effusion*. h = humeral head. **B**. Distension of the sub-deltoid bursa (arrow) due to local effusion* and synovial proliferation°. h = humeral head. **C**. and **D**. Transverse and longitudinal scan showing full thickness tear^ within the supraspinatus tendon (spt). h = humeral head.

Effusion within the sheath of the biceps tendon was a frequent finding: it was observed in 43/194 shoulders (22%), bilaterally in 13 patients, and synovial hyperthrophy was associated in 13 out of 43 joints (30%) (PD signal was also present in 4 of them). In 11 out 43 joints (25%) effusion within the sheath of the biceps tendon was associated with supraspinatus tear (no association with subscapularis or infraspinatus tendon tear was observed)

Effusion within the subacromion-subdeltoid bursa and the subscapular bursa was present in 28 (14%) and in 1 (0.5%) of the 194 shoulders, respectively (Fig. 1).

Synovial hypertrophy was imaged in 57% of subacromion-subdeltoid bursa and in the only involved subscapular bursa (PD signal was also detected in 3 of them).

Effusion in ACJ was detected in 51 out of 194 shoulders (26%). Synovial hypertrophy was imaged in 19 out of 51 ACJ (40%) associated to effusion and only 1 out of them showed PD signal. Osteophytes at the ACJ were observed in 53 (27%) out of 194 shoulders and calcifications in only 2 joints.

The GHJ was rarely involved; in fact joint effusion was found in only 4 shoulders by posterior and axillary US assessment and was associated to synovial hypertrophy in 3 cases with no PD signal (Fig. 1). Labrum calcifications were infrequently detected (4 out of 194 joints).

Enthesophytes at the lesser and greater tuberosity of the humerus were visualised in 26 (13.4%) and in 15 (7.7%) shoulders, respectively; deltoid proximal insertion enthesitis was found in 6 (3%) shoulders. Bone erosions were imaged in 29 (14.9%) shoulders, but no PD signal in the erosions was detected.

No intra-cartilagineous crystal material, precisely "double contour sign", or tophaceous deposits were imaged. Humeral head hyaline cartilage calcification was detected in only 1 shoulder.

By dynamic US assessment, mechanical impingement of supraspinatus and

subscapular tendons was found in 6 shoulders.

Patients with US-detectable shoulder involvement did not differ significantly in terms of disease duration, disease activity and BMI from patients with normal US findings.

Clinical examination frequently failed to detect abnormalities in patients in whom US examination showed pathological findings. This is particularly true for tendon involvement, *i.e.* effusion within the sheath of the biceps tendon was imaged in 43 shoulders but clinical assessment reported abnormalities only in 22 shoulders ($p<0.0001$). Moreover, supraspinatus tendinosis was detected by US in 80 shoulders but the Jobe test was positive in only 35 out of 80 shoulders, subscapularis tendinosis was visualised in 43 shoulders but the Gerber test was abnormal in 18 cases and, finally, the Patte test was positive in 14 shoulders but infraspinatus tendinosis was imaged in 29 shoulders. One patient complained of bilateral pain but no US abnormalities were disclosed.

Thus, it is worth noting that US revealed pathological findings in patients who did not complain of pain at the provocative maneuvers at the time of the clinical examination.

The agreement between clinical and US findings was indeed low, with a non-significant concordance on positive or negative findings.

Discussion

Several studies have demonstrated the utility of US imaging in the evaluation of joints and entheses in patients affected by PsA, a disorder characterised by a great variability in the clinical picture (3-6, 13, 16).

PsA patients frequently complain of shoulder pain but the prevalence and the features of shoulder arthropathy in the course of PsA are still unclear, and has been the topic of very few investigations. In 2002 Falsetti *et al.* (8) performed a retrospective study of clinical, sonographic and radiological examinations of the shoulder in 100 patients with spondyloarthritis (41 of whom were PsA patients) to evaluate the frequency of deltoideal proximal insertion enthesitis (DPIE). The authors concluded that DPIE appears more frequently in PsA than in other spondyloarthritis. DPIE can mimic impingement syndrome but US can differentiate between the two conditions.

Plain radiographs have traditionally been used to detect joint abnormalities in patients with painful shoulder and findings suggestive of the presence of soft tissue pathology can be seen. However, plain radiography may be completely normal even in the presence of a complete rotator cuff disruption and is a poor indicator of inflammatory changes in entheses. In 2007 Helliwell *et al.* (17) reviewed the radiographic evidence of enthesopathy obtained from participants in the CASPAR study and the plain radiographic features of peripheral enthesopathy at major sites were compared between PsA, other spondyloarthropathies and rheumatoid arthritis. Among the many and interesting observations reported in this study, the authors noted that entheseal erosion in the knee, elbow or shoulder of PsA patients was uncommon and rarely detected by plain radiology.

Compared to MRI, US is a relatively inexpensive imaging technique, which provides a rapid diagnosis in specific clinical situations. A complete US examination of the rotator cuff can be carried out in a relatively short time and useful observations on soft tissue structures during movement can be obtained. US imaging technique is, therefore, a sensitive and accurate tool for evaluating the severity of shoulder joint involvement in the course of PsA and can help in planning an adequate treatment of this disease.

In using this technique we frequently identified inflammatory involvement, tendinosis and/or tendon tear of the rotator cuff tendons, with a significantly higher prevalence than that reported in the cohort of healthy subjects studied by Iagnocco *et al.* (11), while no differences in the frequency of tendon calcifications were observed in the same cohorts studied. It is well-known that the frequency of rotator cuff abnormalities progressively increase with age, but even if the mean age of our PsA patients was higher, but not statistically relevant, than that of the healthy subjects (11), we can speculate that rotator cuff tendinopathy belongs to the clinical picture of PsA and may represent a manifestation of the disease. Bilateral tendinosis involving from one to three components of the rotator cuff was also imaged in 29 patients.

We frequently observed effusion of ACJ in PsA. However, synovial hypertrophy was associated to effusion in only 37% of the cases, with PD signal detectable exclusively in 1 shoulder. Osteophytes at ACJ level were observed in less than one third of the shoulders. It is probable that in the case of ACJ, beyond the classical signs of arthritis, we visualised manifestations of osteoarthritis; the clinical picture may thus be difficult to interpret, due to the coexistence of the two disorders.

While effusion within the sheath of the biceps tendon represented a frequent finding, effusion within the subacromion-subdeltoid bursa and the subscapularis bursa and within the GHJ was rarely detected and no significant differences with healthy subjects were observed. This latter data may be unexpected and not easily explained. We can hypothesise that the prevalent damage in PsA shoulder is at the level of the rotator cuff tendons and that arthritis of the gleno-humeral is a rare condition. It should also be considered that the patients were enrolled consecutively and may not have had shoulder pain. However, further studies are needed to provide more information on the fluid topographic distribution in GHJ, also using other imaging techniques (MRI).

Deltoid proximal insertion enthesitis was found in a very limited number of PsA patients, which is in contrast with what Falsetti *et al.* reported (8). This discrepancy may be due to the different sample sizes in the cohorts studied, but the frequency of enthesitis in PsA shoulder still needs to be examined in depth, and we hope that it will be the topic of further investigations.

It is interesting to observe the different results provided by clinical examination and US assessment. Rotator cuff tendinopathy or effusion within the sheath of the biceps tendon were imaged in shoulders which were negative for pain and/or tenderness during clini-

cal examination and the provocative maneuvers utilised. On the contrary, no US abnormalities were detected in one patient who complained of bilateral shoulder pain. These data confirm that clinical examination alone may not be able to diagnose the exact features and the extent of joint involvement in PsA patients, thus running the risk of compromising the choice of a more efficacious therapy (13, 18, 19).

In conclusion, PsA still remains an intriguing and incompletely understood condition in which US examination appears to be a useful and sensitive imaging technique, specifically in identifying joint and tendon involvement of the shoulder.

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